

# LIBERATORS, MUSTANGS AND "ENOLA GAY"

## America Acquires Army Air Power for World War II

Cadet J. Jeremy Marsh, USAF

Being unusually frank, in January 1939, the Chief of the General Headquarters of the Army Air Corps, General Frank M. Andrews, labeled his Air Corps "fifth or sixth rate." Extremely inferior to European air forces, Andrews said that the United States had only slightly more than 400 first-line combat planes, most of which were approaching obsolescence, compared to a German combat air force estimated between 4,000 and 10,000. By beginning to build up the U. S. air force, he continued, we were "saying in unmistakable language, 'Hands off the Western Hemisphere—America is for Americans.'" If ever, now was the time.

Indeed, the massive buildup of American air power that took place from 1940-45 transmitted this mes-

sage in terms no one could mistake. By the end of World War II (WWII), the status of not only American air power, but of global air power as a whole with its potential affect on both war and peace, had changed drastically.

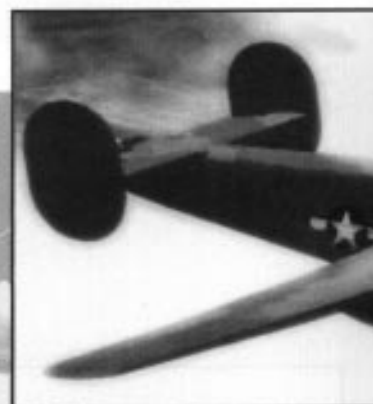
As we commemorate the 50th anniversary of WWII, in which the Army Air Forces (AAF) played a decisive role in contributing to the Allied victory, *Program Manager* discusses how American science, industry and a dynamic acquisition process were harnessed to unleash the world's most powerful air force.

### The Airmen Arrive: From Air Corps to Air Force

To understand how the United States acquired such an air force, one must review the evolution of the AAF role within the War Department. In 1939, the Army had almost total control over its air arm, labeled the Army Air Corps. The War Department retained some residual control.

When Henry L. Stimson became Secretary of War in June 1940, he took steps with Army Chief of Staff General George C. Marshall to increase the role of Army airmen. Seeing the need for someone who could act as a "Secretary of the Air Force," Stimson appointed Robert A. Lovett as Assistant Secretary of War for Air,

B-24 photo courtesy U.S. Air Force



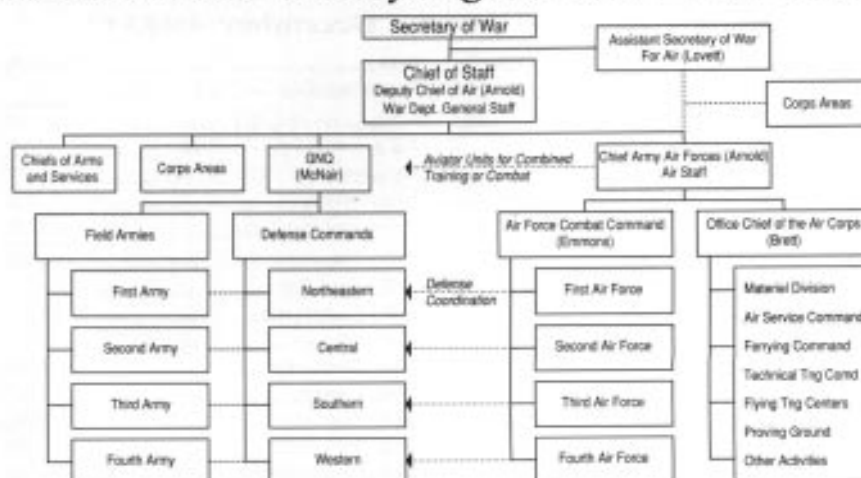
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a position responsible for Air Corps procurement, organization and public relations. Soon afterwards, General Henry H. "Hap" Arnold, one of the Army's first pilots and, like Marshall, a West Point graduate, became Acting Deputy Chief of Staff for Air.

Despite these changes, airmen still lacked what they believed to be the three essentials for organizational success: a separate air staff, a unified air arm, and an air force coequal with

**FIGURE 1. AAF in Army Organization — Late 1941**



ground and service forces. Not until a year later, 20 June 1941, did the Army establish the AAF from the old Air Corps, giving airmen two of their desired essentials: an air staff and a single commanding general (Arnold). Finally, on 9 March 1942, the War Department was divided into three separate coordinate forces for ground, air and services. Thereafter, the AAF functioned on a level basically equivalent to that of the Army and Navy, and remained so until 1947, when the National Security Act established the U.S. Air Force as a separate branch of the military.

### Building an Air Arm, 1939-40

*Air power is not a commodity that can be procured in the open market, no matter how much gold and silver may be available. Money will not buy it, desire will not create it. Timely foresight, based upon an intelligent conception of the potentialities of air power and its effect upon the destiny of nations, is the only formula that can assure its development.*<sup>2</sup>

— General Frank M. Andrews, 16 January 1939

On overlay of cockpit of "Fifi," Boeing B-29 Superfortress of the Confederate Air Force (CAF), are shown the Consolidated B-24 Liberator bomber in flight during World War II (WWII), and the CAF's "Diamond Lil," a restored WWII B-24.

**TABLE 1. Army Air Forces: Procurement Deliveries of Airplanes, January 1940 - December 1945\*\***

Item	Quantity	Item	Quantity
Airplanes — Totals, all Types	231,099	Reconnaissance — Total	1,117
Very heavy bombers — Total	3,899	F-2 (version of C-45)	55
B-19 (Delivered in 1941)	1	F-4 & F-5, (version of P-38)	500
B-29, Superfortress	3,898	F-6 (version of P-51)	299
Heavy bombers — Total	31,000	Other models	263
B-17, Flying Fortress	12,692	Transports—Total	22,885
B-24, Liberator	18,190	C-43, Traveller	352
B-32, Dominator	118	C-45, Expeditor	1,771
Medium bombers — Total	16,070	C-46, Commando	3,180
B-25, Mitchell	9,816	C-47, Skytrain	10,368
B-26, Marauder	5,157	C-54, Skymaster	1,162
Other models	1,097	C-60, Lodestar	620
Light bombers — Total	18,113	C-61, Forwarder	1,009
A-20, Havoc	7,385	C-64, Norseman	756
A-24, Dauntless	615	C-69, Constellation	15
A-25, Helldiver	900	C-78 (AT-17 type), Bobcat	3,206
A-26, Invader	2,450	C-87, Liberator Express	291
A-28 & A-29, Hudson	2,189	Other models	155
A-30, Baltimore	1,575	Trainers — Total	55,712
A-31 & A-35, Vengeance	1,931	AT-6, Texan	15,094
A-36 (P-51 type), Mustang	500	AT-7, AT-10 & AT-11, Navigator (AT-7)	5,775
Other models	568	AT-8 & AT-17, Bobcat	2,153
Fighters — Total	68,712	BT-13 & BT-15, Valiant	11,537
P-38, Lightning	9,536	PT-13, PT-17 & PT-27, Kaydet	7,539
P-39, Airacobra	9,588	PT-19, PT-23 & PT-26, Cornell	7,802
P-40, Warhawk	13,738	Other models	5,812
P-47, Thunderbolt	15,683	Communications—Total	13,591
P-51, Mustang	14,686	L-1, Vigilant	324
P-59, Airacomet (jet propelled)	66	L-2, Grasshopper type	1,940
P-61, Black Widow	702	L-3, Grasshopper type	1,439
P-63, Kingcobra	3,292	L-4 & L-14, Grasshopper type	5,611
P-70, night fighter type of A-20	60	L-5, Sentinel	3,590
P-80, Shooting Star (jet propelled)	243	R-4 & R-5 (helicopter)	161
Other models	1,118	R-6 (helicopter)	224
		Other models	302

\*\* Data represent factory acceptances or receipt of legal title by resident factory representative of procuring agency. Includes all airplanes procured by the AAF regardless of subsequent distribution to Army, Navy, recipients of Lend-Lease, or others. These airplane deliveries represent approximately 83 percent of all Army Air Forces procurement.  
Source: United States Army in World War II: The War Department; The Army and Economic Mobilization.

Andrews and his fellow airmen had a long way to go in their quest to develop a true U.S. air power. Prior to 1939, the Air Corps, like other branches of service, suffered from the neglect that typically characterizes our nation's attitude toward the armed forces after a war. Planes were lacking both quantitatively and qualitatively, and the acquisition process was decentralized and unorganized.

However, as autumn 1939 drew near, and war in Europe appeared certain, President Franklin D. Roosevelt saw the requirement for

expanding the armed forces, especially the air arm.\* On 12 January 1939, the President pleaded to Congress that \$300 million be allotted for a minimum increase of 3,000 planes. He asked that orders be placed on such a large scale to reduce their cost and enable the procurement of even more. By April, Congress authorized the Secretary to "equip and maintain

\* Reference to the term "air arm" is only to the Army Air Forces, which constituted the majority of U.S. air power in WWII, and does not include Navy and Marine Corps aviation.

the Air Corps with not to exceed 6,000 serviceable airplanes...together with spare parts, equipment, supplies, and hangars."<sup>3</sup>

When Nazi Germany invaded Poland on 1 September 1939 and launched WWII, the Air Corps had barely commenced expanding. Its strength was approximately 25,000 men and 800 first-line planes, compared to the German Luftwaffe's 500,000 men and 4,000 planes, and 100,000 men and 2,000 planes of the British Royal Air Force. An American historian said, "It would require several years of expansion and development before the United States could regard itself as a peer among the air powers of the world."<sup>4</sup>

In fact, in 1939, most of the planes with which the United States would fight in WWII had not even been developed. The saviors of American air power simply were time (the passage of world events) and geography (the protection of two oceans), which permitted America the space to execute the necessary air expansion. Without it, an Allied victory would have been much more difficult and lengthy to achieve.

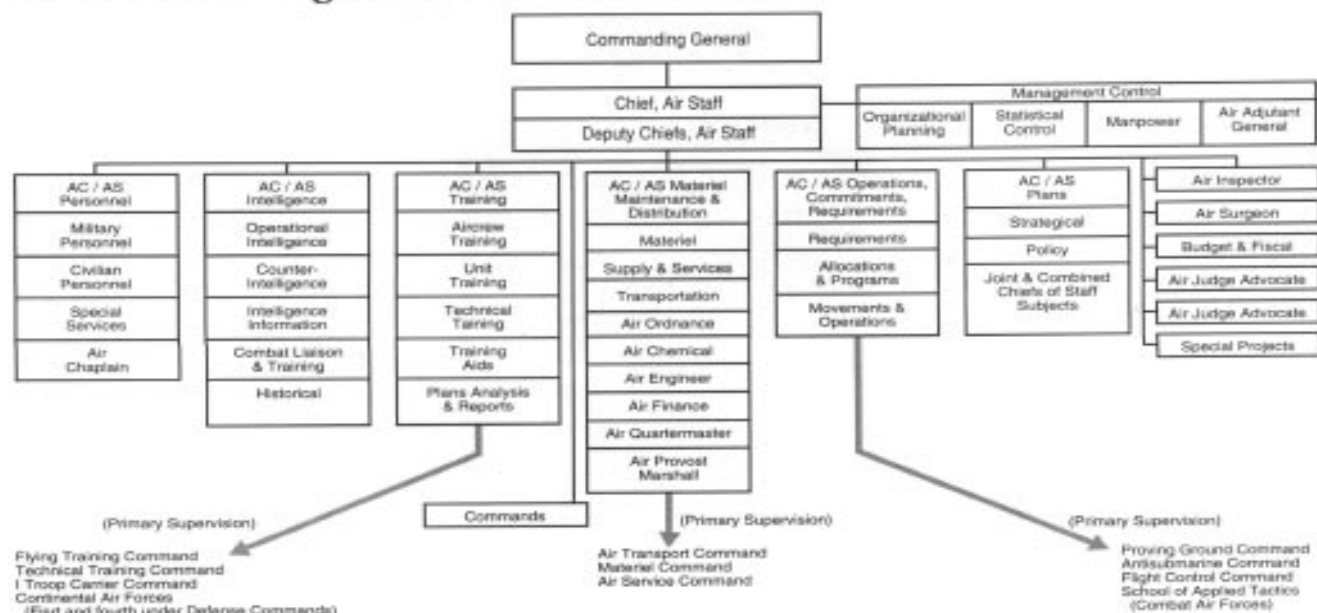
### Manufacturing in the Immediate Pre-War Period

*The expansion of the aircraft industry during WWII was the most dramatic development of the period. Large shipbuilding operations were not new; mass production of ordnance items was well established; but the manufacture of airplanes in production quantities had never been attempted in the United States.<sup>5</sup>*

— S.A. Zimmerman,  
historian

Because it was a fairly new development, aircraft manufacture presented unique difficulties to procurement and production planning bodies in 1939 and 1940. Since World War I (WWI), industry had been hand-to-mouth in which every military air-

**FIGURE 2. AAF Organization — March 1943**



plane was custom tailored. Military leaders applied no pressure on designers to think up an airplane that they could mass produce in an emergency. One solution to the problem of mass production was to freeze standard aircraft designs.

In 1940, automobile manufacturer Henry Ford believed he could produce 1,000 aircraft per day as long as the "frozen" design was not interfered with by "men who haven't kept up to date in airplane design and operation."<sup>6</sup> The notion that designs could be frozen was unrealistic, as World War I (WWI) experience showed.

In WWI, a group of "experts" (progressive businessmen and engineers)

were able to convince the public and, more importantly, Congress of the need to mass produce aircraft. These experts believed that aircraft manufacturers could carry out aircraft production in the same manner that Ford's plants carried out car production and by so doing create an air force. However, "Fordism" was not a success because its system was too inflexible for making wood, wire and fabric flying machines. In addition, the rapid rate of technological advancement made it impossible to mass produce a state-of-the-art plane, a difficult task even today.\*

In July 1939, Arnold initiated a meeting of 18 industry heads and asked them two questions: First, was

the capacity of the aircraft industry sufficient to "absorb the load...of the Expansion Program, and at the same time take care of the Navy load, plus the commercial load and any other load that may be put upon it by foreign orders?"<sup>7</sup> Second, what steps were necessary to expand the industry to meet the emergency wartime requirements that might be placed on it? Though the meeting produced good discussion, few tangible outcomes ensued. Industry had little incentive to standardize its mass-production methods or to expand its capabilities.

In 1939, aircraft companies were averse to expansion because a war boom was still unpredictable. With the Great Depression still fresh in their minds, they hesitated to invest in plants which they might have to dump into a post-war downturn. Too, in 1940, the European theater stag-



The "Creeping Death" — North American P-51 Mustang World War II fighter in flight.

Courtesy U.S. Air Force

\* For more information on WWI aircraft acquisition, see Wilbur D. Jones, Jr., "Spruce, Dope and Fordism: The Flying Coffins; America Acquires an Air Arm, Wright Brothers Through the Great War," *Program Manager*, July-August 1993.



nated into the "Phony War" when both the Germans and the allies played "wait-and-see." The overriding question was whether the Americans would join the allies or remain neutral.

Four options for expansion were available to industry: government factories, an increase in plant capacity, more subcontracting to smaller aircraft firms and organizations outside of the aircraft industry, or conversion of certain industries such as the automotive one. In light of such uncertainty, industrialists favored the second option, provided the government would cover expenses associated with expansion: If the government wanted military airplanes, it must accept some of the risks.

Despite its attitude, in 1939 the industry was in the best condition of its short life. It employed 50,000 people, which was more than ever before; it ranked 41st among American industries with an output of almost \$280 million; and by 1944, it would transform into the country's largest industry in business and earnings volume. Where in 1940 the aircraft industry produced some 13,000 aircraft, less than half military, in 1944 alone it turned out 96,000 military planes. Furthermore, industry's overall production in the 62 months between July 1940 and August 1945, during which time floorspace increased twelvefold and manpower sixteenfold, was 300,000 military planes at a cost of more than \$45 billion.

Two factors in 1939 encouraged industry to begin expansion: persistence by the Air Corps, and foreign orders. To meet an annual requirement for 40,000 aircraft, the Army estimated that industry and government would have to construct 20 new factories, each capable of producing 1,200 planes. Foreign military orders, growing out of a desperate attempt by Britain and France to offset Luftwaffe superiority, provided the greatest



President Franklin D. Roosevelt, left, visits Bolling AFB, Washington, D.C., prior to World War II, accompanied by General Henry H. Arnold and Assistant Secretary of War Louis Johnson.

stimulus. Virtually all leading airframe manufacturers (Lockheed, Glenn L. Martin, Wright Aeronautical, Boeing, North American and Douglas) and engine manufacturers (Pratt and Whitney and Wright Aeronautical) increased their floor space because of British and French orders.

Foreign orders were intensifying in 1938. However, because of America's security interests, foreign countries had to accept less than the best as the latest models were withheld. Once the war began, invocation of the Neutrality Act penalized the victims of aggression who had formerly bought arms from America. Roosevelt convinced Congress on 4 November 1939 to lift the arms embargo and allow foreign countries to continue purchasing arms on a "cash and carry" basis. The government also decided to release some of its newer models to the British and French, including the B-18A and the P-40, and later the B-17, B-24, P-38 and P-51. With this new release policy, contracts skyrocketed.

In July 1940, after France fell, Britain alone had 8,275 planes and 21,485

engines on order. As 1940 closed, and the gravity in Europe became clearer, Roosevelt proclaimed the United States as the "arsenal of democracy" by offering complete service to the British. On 11 March 1941, the new Lend-Lease program authorized the transfer of weapons and equipment to countries whose defense was considered vital to the defense of the United States, which later included Russia.

Aircraft industries were receptive to orders from abroad because they made larger profits than from Army contracts. Yet, Army leaders knew that foreign competition would willingly pay for necessary plant expansion so manufacturers could meet their needs. Thus, American productive capacity was paid for largely by Britain and France.

#### 50,000 Planes a Year

*Air power has decided the fate of nations; Germany, with her powerful air armadas, has vanquished one people after another. On the ground, large armies had been mobilized to resist her, but each time it was additional power in the air that decided the fate of each individual nation.<sup>8</sup>*

— Secretary Henry L. Stimson,  
9 August 1940

The most influential push to expand the war came on 16 May 1940, when Roosevelt shocked the nation by calling for 50,000 planes a year. Even though the number now appears to have been more of a psychological target, used to accustom planners to think big, its effect was momentous.

Perhaps the most significant effect was to correct a situation where Congress, through is appropriations power, determined Army aircraft requirements, rather than by a true study of Army needs. Congress now began appropriating liberally with little question. This created an incredible burden on AAF program managers to

decide how to use the large influx of funds to meet the AAF original goal of 36,500 aircraft per year (their share of the 50,000).

The AAF officers worked day and night to complete the contracts, signing as many as 1,000 a day at Wright Field, Dayton, Ohio, for everything from boots to bombers. Indeed, the billions of new dollars threw the AAF procurement system into a maelstrom of activity. As an observer said, the clarity of the President's 50,000 goal soon became a "hodgepodge of piecemeal appropriations, overlapping procurements, compromises in timing, and uncertainties in composition."<sup>9</sup>

Therefore, program management became the ability to deal with a patchwork of programs that were each a compromise or an *ad hoc* solution. Industrial mobilization became, by necessity, makeshift and disordered, demonstrating why number goals, procurement and production organizations, and the production record constantly changed throughout the war.<sup>10</sup> Consequently, trial and error formed the basis upon which many of these changes were made, which was certainly evident in the evolution of government organization for production.

In late May, the President summoned the National Defense Advisory Commission (NDAC) to Washington. The Commission was composed of seven industrial specialists, and included General Motors president William S. Knudsen. He established the NDAC production division and negotiated for the placement of Air Corps materiel orders, helped allocate plants, found subcontractors, and decided upon expansions.

The Air Corps had to clear all large munitions orders through Knudsen's office, and he reviewed every contract. This did not mean the Services relented control of their own procurement. Rather, the NDAC, and later the Office of Production Management

## BOMBER PRODUCTION IN WWII: THE B-24 LIBERATOR

The AAF paid more attention to the bomber, specifically the heavy bomber, than any other airplane. The AAF leaders believed that high-altitude daylight precision bombing was the key to air war success. We will examine briefly the acquisition of the bomber whose production volume exceeded that of all others, the Consolidated-Vultee B-24 Liberator.

The earliest phases of B-24 design began in September 1938. In January 1939, Arnold petitioned the Consolidated Aircraft Company to produce a four-engine bomber with a range of 3,000 miles, a top speed above 300 mph, and a ceiling of 35,000 feet. All specifications exceeded that of the in-service B-17, and Air Corps officials saw it as a superior aircraft. With its crew of 10, the B-24 could carry a heavier bomb load (2,500 lbs.) and carry the load farther (2,850 miles). The Army contracted in March 1939 for a prototype which was produced and test flown in December.

The Air Corps determined that the heavy bomber production was too great for one manufacturer and helped form a manufacturing pool for the B-24 consisting of leading aircraft manufacturers, Consolidated and Douglas, and Ford Company, manufacturer of engines. Douglas and Ford were tasked to aid Consolidated by providing 100 planes per month above what it could produce. This arrangement enabled the AAF to receive the bombers when it needed them. These manufacturers did not complete the first production until June 1941, and the 500th acceptance did not occur until a year later in 1942.

By January 1942, some manufacturers were subcontracting almost 50 percent of their work. Experts have estimated that subcontracting accounted for up to 30 percent of all the poundage of aircraft produced during the war. Subcontracting was especially common for the bomber producers because production was so complex. Consolidated depended on as many as 100 subcontractors, many of whom also depended on subcontractors. Still, this number is nowhere near the more than 1,000 subcontractors Boeing used in producing the B-29. Approximately 162,000 subcontractors contributed to the aircraft industry.

The accelerated production rate record revealed much about B-24 acquisition and answered the question: Just how fast could a plane designed in the late 1930s and early 1940s be mass-produced and put to use? The time between design commencement and the 500th acceptance was 3.5 years — remarkable considering the plane's size and complexity. The most significant year for producing heavy bombers of all types was 1942, particularly in terms of the weight produced (an 862 percent increase over 1941). Though aircraft production costs increased from 1940-45, the cost of producing a B-24 decreased significantly due to the increased efficiency from volume production.

The Liberator proved effective in many utility roles and combat theaters. Like many aircraft it came in numerous versions, reaching all the way to the B-24M modification. Quantity production began at model D, which along with models H and J saw the most combat. The B-24 was also a successful tanker and transport. Pilots in action from Burma to Nazi-occupied Europe, from the Aleutians to the Mediterranean, and from Japan to Germany hailed the twin-tailed Liberator as one of the sturdiest and most dependable planes. The plane's successes were widespread, but, like any aircraft, it had its faults, including weaknesses in armament and armor.

**TABLE 2. Aircraft Design to 500th Airframe Acceptance**

Start of Design	Prototype First Flown	First Production Article	500th Acceptance	Approximate No. of Years
B-17 ..... Aug. 1934	1935	1939	Apr. 1942	7.75
P-39 ..... June 1936	Apr. 1939	Sept. 1940	Oct. 1941	5.25
A-20* ..... 1937	1938		May 1941	4
P-40 ..... Mar. 1937	Oct. 1938	May 1940	Nov. 1940	3.5
P-38 ..... June 1937	1938	Sept. 1940	Apr. 1942	4.75
B-25 ..... Feb. 1938	Feb. 1941	Feb. 1941	Apr. 1942	4.25
B-24 ..... Sept. 1938	Dec. 1939	June 1941	June 1942	3.75
B-26 ..... June 1939	Nov. 1940	Feb. 1941	July 1942	3
P-51 ..... May 1940	1940	Aug. 1941	May 1942	2
B-29 ..... June 1940	Sept. 1942	July 1943	July 1944	4
P-47 ..... July 1940	May 1941	Dec. 1941	Dec. 1942	2.5
A-26 ..... Jan. 1941	July 1942	Sept. 1943	Nov. 1944	3.75

\*The A-20 was originally the Douglas DB-7, and the first production article probably flew in 1938 or early 1939. It is likely that the 500th acceptance occurred before May 1941.

Sources: *The Army Air Force in World War II: Men and Planes*

(OPM) and the War Production Board (WPB), devoted themselves to providing the raw materials, tools and facilities necessary to produce weapons and equipment, not to controlling procurement.

Roosevelt replaced the NDAC with the OPM at the end of 1940. This agency was less advisory and more authoritative, and included the Secretaries of War and the Navy and a director, Knudsen. Even though it had more power to act, the President felt

that the OPM suffered from a lack of real supervisory authority over military acquisition practices. So, in January 1942, he replaced the OPM and its operating agency — the Supply, Priorities, and Allocations Board — which was also a failure, with the WPB.

By this time, the fear created by the Japanese attack on Pearl Harbor on 7 December 1941 had caused American industrial leaders to change their minds about economic regimentation.

Before then, Roosevelt would have exercised bad politics to give any real authority to the WPB predecessors, despite the fact that government control was the norm in the 1930s. Anyhow, with the creation of the WPB, the Army-Navy Munitions Board now had to report to the WPB Chairman, Donald Nelson, who would check the requirements of the Services according to the availability of materials. The WPB exceeded the effectiveness of its predecessors because it had the power to collect the facts from the Services.

The Joint Air Advisory Committee, which the Army and Navy coestablished in 1940, was also instrumental in organizing production. It probably could have continued the task of coordinating procurement within the two Services were it not for the overwhelming presence of foreign aircraft contracts. These made it necessary for Stimson to appoint a new committee, the Army-Navy-British Purchasing Commission Joint Committee, which later became known as the Joint Aircraft Committee (JAC). Included on the JAC were two members each from the Army, Navy, British Purchasing Commission and the OPM. It had the power "to schedule the delivery of, and allocate the capacity for, aircraft and aircraft components in the official program for all customers, Army, Navy, and British, and other Foreign and Commercial."<sup>11</sup> The JAC also had a final say on matters relating to standardizing aircraft and aircraft components.

### Aviation Objectives And AWPB-1

The Air Corps wasted no time responding to the call for 50,000 planes. The first response, called the Army's First Aviation Objective, included plans to expand the Air Corps to 54 combat groups (4,006 combat aircraft) and six transport groups. Stimson approved this on 12 July 1940. Shortly after this Objective was underway, Marshall wrote the Army's Second Aviation Objective to augment exist-



Courtesy Air Force Academy Archives

Government and industry leaders confer at the Army Air Corps Materiel Lab, Wright Field, Dayton, Ohio, in August 1940. From left to right: Charles F. Kettering; Major General Henry H. Arnold; William S. Knudsen, Director of the National Defense Advisory Commission; and E. V. Ripperville, director of the General Motors Research Laboratory.



ing groups. But the number of planned groups shot up to 84, including 7,800 combat planes. On 14 March 1941, Stimson approved the second Objective, believing it was "necessary for hemispheric defense."<sup>12</sup>

Arnold directed the AAF Air War Plans Division (AWPD) to answer Roosevelt's request for production requirements to defeat potential enemies. The small group who developed the response, AWPD-1, went far beyond Roosevelt's and Arnold's expectations. Completed in August 1941, AWPD-1 was the first major strategic air war plan of the AAF, marked the zenith of prewar air force doctrine, and provided a blueprint for the air war to follow.<sup>13</sup>

Expecting the United States would fight an offensive air war, the AWPD-1 planners called almost exclusively for the production of long-range bombers. Planners expected that by 1943 or 1944, the AAF would include 203 combat groups, 108 observation squadrons, and a total of 59,727 airplanes, of which the majority would be bombers and trainers. Even Arnold thought it peculiar "that the plan called for only 13 experimental escort fighters but called for 3,740 of the 4,000 mile-range bombers, when the latter would be just as much a developmental problem as the former."<sup>14</sup>

Although the Joint Army-Navy Board did not accept AWPD-1 entirely, the plan still constituted the definitive statement of AAF strategic and production needs as the winter of 1941-42 approached. The AWPD-1 planners were not far off in their ultimate goal of 239 groups by the end of the war; in 1945, 243 groups had been equipped.

#### America on the Verge of War

Late in 1941, the AWPD produced AWPD-4, "Air Estimate of the Situation and Recommendations for the Conduct of War." It proved too bold a step for the Joint Chiefs of Staff (JCS), and in January 1942, they voted



General Henry H. "Hap" Arnold, USA, commander of the Army Air Forces in World War II.

Instead to accept AWPD-1 with modifications. The message was that airmen must accept that mobilization of all military forces meant a reduction in the aircraft production priority.

The AAF received a measure of autonomy on 9 March 1942, when the War Department was consolidated into three coordinate forces, each under a commanding general. They were the Army Air Forces, the Army Ground Forces (AGF) and the Services of Supply (later the Army Service Forces (ASF)). General Headquarters, the Office of the Chief of Air

Corps, and the Air Force Combat Command all became defunct.

The AAF mission was "to produce and maintain equipment peculiar to the Army Air Forces, and to provide air force units properly organized, trained, and equipped for combat operations."<sup>15</sup> The AAF literally became a subordinate command within the Army, which did not indicate autonomy, but in actuality the AAF became a separate force more similar to the Army and Navy than to the AGF or ASF. Arnold was made a member of the JCS and the Combined Chiefs of Staff on an equal plane with Marshall, technically his superior. The unique nature of AAF acquisition made it necessary for the AAF to deal with such matters within its branch rather than let the ASF do it for them. Coordination problems between the two agencies were not uncommon, but essentially the AAF was its own force.

Arnold submitted a new plan, AWPD-42, "Requirements for Air Ascendancy," which requested 131,000 planes, of which the AAF's share would be used for 281 groups. The Navy sharply challenged Arnold, forcing him into a compromise of 107,000. Although this in effect marked the end of the aircraft transcendent priority among categories of munitions, airmen had little cause for complaint.



Early war model of the P-51 Mustang similar to the one built for British use. Readers may note its similarity to the popular high-performance British Spitfire.



Instead, many AAF leaders feared that an abundance of planes might outrun the availability of air crews or shipping to support them in combat theaters.<sup>16</sup> The AAF had been assured it would get the necessary material to prosecute its war.

After Pearl Harbor, the Aircraft Production Division became almost separate within the WPB, leading to the development of an Aircraft Production Board (APB) in December 1942, under the leadership of WPB vice-chairman Charles E. Wilson. The WPB soon assumed central direction of all aircraft production including scheduling, and established the Aircraft Resources Control Office (ARCO) as its executive agency. This agency acted for the board in all matters relating to manpower, materials and machine tools, and it directed the efforts of the Aircraft Scheduling Unit. The APB, ARCO and Aircraft Scheduling Unit constituted the most important aircraft production agencies outside the military, while the JAC remained dominated by the military.

The AAF controlled its own acquisition process by establishing the Materiel Command in 1942. Its top staff was in Washington, but its operating arm was at Wright Field. Major



Major General Oliver P. Echols, Commander, Army Air Forces Materiel Command.

General Oliver P. Echols, commander of the Materiel Command, was Arnold's chief acquisition adviser throughout the war and directed procurement programs. Echols' extensive experience as engineer and administrator made him well qualified. He represented the AAF on the APB, and he or other members of his staff also served on other War Department committees.

The manufacturers provided the final link in the organizational chain by voluntarily forming the National

Aircraft War Production Council, Inc., in 1943 to coordinate nationwide efforts. The Council effectively served as a research and information agency and provided a medium of exchange for process improvements to best meet government needs. Some manufacturers pooled resources to obtain the highest quality products, such as the Boeing-Vega-Douglas committee which codeveloped the famous Boeing B-17 Flying Fortress. Without such coordination, the AAF would not have received the B-17 or many other planes in the numbers or when desired.

### Massive Expansion: Industry Mobilization

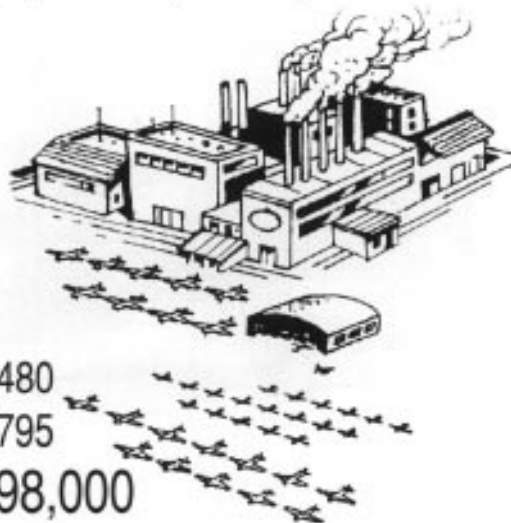
None of the new expansion plants which the government authorized to produce combat planes got into full production until 1943. However, many existing plants had expanded adequately to produce enough planes at least to get the country through the first year of the war. As the barriers which hindered full-scale production before the war dropped, the government pressured producers to build the air force it would need, and made some bold moves of its own. With Assistant Secretary Lovett leading the way, the government contracted for six enormous new assembly plants.

One significant problem was that of balancing mass production (quantity) with quality. Decision makers wrestled constantly with whether or not to freeze design and facilitate production, or to change design and improve quality. One can reasonably assert that perhaps no other problem confronted these officials with hard choices as consistently as this one.

Before the war ended, air arm officials did compromise on the quantity/quality equation by modifying aircraft at one of 20 AAF modification centers. Industry could stabilize airframe or engine assembly lines for quantity without worrying about constant change. Quality improvements and changes took place at the centers. The drawback was the high cost, which was, by nature, makeshift and

**FIGURE 3. Funds Appropriated for Army Aviation**

1931 .....	\$38,892,968
1933 .....	\$25,673,236
1935 .....	\$30,917,702
1936 .....	\$50,287,197
1937 .....	\$62,606,727
1938 .....	\$67,308,374
1939 .....	\$74,099,532
1940 .....	\$243,941,941
1941 .....	\$3,893,287,570
1942 .....	\$21,950,242,480
1943 .....	\$10,615,132,795
1944 ...	\$23,655,998,000



Source: *Procurement in the United States Air Force, 1928-1948: Production Phases 2.*



Courtesy Boeing Archives

B-17 Flying Fortresses, fresh off the Boeing assembly line in Seattle, Wash.

expedient work. By 1943, it became difficult to tell where the production line finished and the modification line began. One center reported 8,000 man-hours modifying a plane that took producers 9,000 man-hours to build.

Another wartime action that contributed greatly to the AAF success

was converting the automobile industry. Prior to Pearl Harbor, the automobile industry was one of the only nonaircraft industries that contributed to aircraft production by producing munitions, engines and other parts. Yet, car and aircraft manufacturers were uncertain about how great the automotive industry contribution should be: perhaps smaller, especially

to airframe manufacturing. Soon the auto industry was on its way.

First, certain steps were necessary. The WPB halted all civilian passenger-car and light-truck production after 31 January 1942. Industry then organized the Automotive Council for War Production to coordinate dealing with government agencies. Gov-

**TABLE 3. Major DPC Facilities Sponsored by War Department**

Total Cost — 26 Projects.....					\$1,539,985,550		
Rank	Company and Locations		Cost to U. S. Government	Rank	Company and Locations		Cost to U. S. Government
1	Chrysler (Dodge)	Chicago, Ill.	173,647,431	14	Continental Aviation	Detroit, Mich.	41,971,682
2	Basic Magnesium	Las Vegas, Nev.	132,695,356	15	General Motors (Fisher Body)	Flint, Mich.	39,156,924
3	General Motors (Chevrolet)	Buffalo, N.Y.	120,055,095	16	Packard Motor	Detroit, Mich.	38,256,297
4	General Motors (Buick)	Melrose Park, Ill.	110,009,223	17	Curtiss-Wright	Cheektowa, N.Y.	36,386,370
5	Ford Motor	Willow Run, Mich.	86,595,661	18	Sperry Gyroscope	North Hempstead, N.Y.	36,380,123
6	Studebaker	South Bend, Ind.	77,724,127	19	Wright Aeronautical	Paterson, N. J.	34,113,760
7	Wright Aeronautical	Lockland, Ohio	74,859,211	20	North American Aviation	Grand Prairie, Tex.	32,604,623
8	Wright Aeronautical	Woodridge, N. J.	65,029,598	21	Standard Steel Spring	Madison, Ill.	30,231,525
9	General Motors (Allison)	Speedway City, Ind.	62,541,329	22	Curtiss-Wright	Columbus, Ind.	29,608,849
10	Ford Motor (Rouge)	Dearborn, Mich.	59,800,671	23	Thompson Aircraft Products	Euclid, Ohio	29,123,338
11	Dow Magnesium	Velasco, Tex.	56,514,718	24	Higgins Aircraft	New Orleans, La.	28,719,042
12	Mathieson Alkali Works	Lake Charles, La.	48,867,624	25	Boeing Airplane	Wichita, Kan.	26,781,232
13	Dow Magnesium	Marysville, Mich.	42,228,327	26	American Steel Foundries	E. Chicago, Ind.	26,083,414

Each project represents a complete plant or major addition to an existing establishment. Nos. 15, 21, and 26 sponsored by Ordnance; all others by Army Air Forces. Nos. 2, 11 and 13 involved only a contingent liability of War Department; all others required cash-outlay.  
Source: United States Army in World War II: The War Department; The Army and Economic Mobilization.

ement and industry transitioned to war production as quickly and easily as possible so that by June 1942 most of the industry had begun conversion. The magnitude and success outdid expectations. By the end of the war, General Motors ranked first in government contracts dollars for aircraft production expansion (\$922 million). Even though the automotive industry did not produce many airframes, it did build well over half of all aircraft engines produced between July 1940 and August 1945, and about two-thirds of all combat engines.

### Research and Development

*The first essential of air power is preeminence in research.<sup>17</sup>*

— **Lieutenant General Ira Eaker,**  
**6 September 1945**

When Eaker made this statement, the AAF had just accomplished what no air force had ever before accomplished. It delivered the *coup de grace* that finished a war. Preeminent research was certainly the impetus behind such a victory, especially when one considers the novelty of the atomic bomb.

American leadership in research and development (R&D) was behind Europe and did not evolve until America declared war. Little aeronautical research took place at American universities, and manufacturers had little incentive to conduct any. The one bright spot was the National Advisory Committee for Aeronautics (NACA), which was responsible for almost all fundamental research prior to and during the war. It was appropriated \$2 million each year, and had 500 employees operating at Langley Field, Va.

Despite NACA success, three considerations plagued the Air Corps in December 1941: the assumption that America would fight only a defensive war, the lack of clarification between the Services concerning responsibilities for defense, and a lack of R&D funds. But, war quickly brought Ameri-

can R&D the necessary financial and intellectual resources.

At first, the priority was on the quantity of aircraft produced, rather than quality that springs from R&D. After the first wave of expansion in 1940, Air Corps leaders sought to balance the two, foreshadowing an enormous expansion of R&D into 1945. Expenditures for aeronautics R&D increased from \$250 million to more than \$800 million. In 1944, the AAF budgeted more than \$121.6 million compared to \$10 million in 1940. In total, the AAF spent more than 25 percent of all government R&D funds during WWII. The magnitude allowed the AAF, the Navy and the NACA to expand R&D facilities beyond their wildest prewar dreams.

The United States did not lead the way in all new technologies. For example, in jet propulsion we lagged far behind Germany and Britain, a failure described as "the most serious inferiority in American aeronautical development which appeared during the Second World War."<sup>18</sup> Although the AAF accepted 115 jet-propelled P-80s, none actually saw combat.

### Congress and the Appropriations Business

During the interwar years, Congress clearly neglected the nation's air arm, constantly disappointing Air Corps officials. Responsibility fell on

Congress and everyone who participated in the budgetary process, including military officers. Indeed, the limited funds Congress made available for aircraft procurement reflected a greater problem — the inadequate system of defense budgeting. Also, the Air Corps suffered from a lack of vision in the military and Congress. No one could state the roles or needs of aviation; it was still too new. Had Congress overabundantly appropriated for air, funds likely would have been wasted unless accompanied by a vision and suitably perfected procurement methods.

Congress had made the task of building an air force difficult by enacting legislation which limited profits, ensured competition, forced the military to "buy American," and protected labor. In 1938, Arnold began a campaign for a split-award bill that would modify the profit limitations imposed on all procurement by the Vincent-Trammell law and allow airmen to use certain negotiated contracts. Congress held out on the competition issue because industry made it clear they were opposed to abandoning competition in quantity procurement. It did not pass until March 1940.

Virtually all prewar acquisition problems disappeared when Roosevelt issued his 1940 call for 50,000 aircraft. Where Congress had



*This picture captures much of the atmosphere of the Pacific air war. Engineers, often Seabees, hacked out good airstrips on coral atolls and put palm trees to good use, but when the aircraft was the B-24 Liberator, space was often tight and dispersal impossible.*

Photo source: Classic Aircraft Bombers, Filmways Co., New York, 1978





Boeing factory workers mark a milestone B-17 delivery by autographing the fuselage.

previously refused to see the emergency, they now asked, "what can we do to strengthen the nation's air arm; what are your needs?"<sup>19</sup> Congress enacted emergency legislation which cancelled all profit limitations, mandatory competition and strict labor protection, and approved vast appropriations and bills to speed up the procurement process. Thus Congress tried to "buy back yesterday." Congress appropriated more than \$72.29 billion for the AAF between 1939 and 1945, gave the military broad discretionary powers, abolished restrictions on contract negotiations, and passed a bill which authorized the President to contract without regard for existing law, when to do so would "hasten the war effort."<sup>20</sup> In effect, after 1939 any blame for difficulties within the Air Corps rested more on the General Staff than Congress. However, the General Staff, "which had viewed the sky through smoked glasses, so to speak, since the days of Billy Mitchell," initially held no vision of air power necessity.<sup>21</sup>

#### Government Aid to Manufacturers

Because most manufacturers began expansion with neither the necessary capacity nor mindset, and were unwilling to bear the risks alone, they demanded that the government ac-

cept some risk. The government then developed specific ways to aid them, and focused on one: The government would own the facility and pay the bills; private industry would do the work.

The Defense Plant Corporation (DPC), organized in August 1940 as a subsidiary of the Reconstruction Finance Corporation (RFC), soon became the foundation upon which the bulk of war plant financing was built. In most cases, the government built the plant through the DPC and then leased it to a private company for operation. The DPC and other government aid proved crucial in the rise of industrial capacity and production. Of the \$3 billion the War Department sponsored through the DPC, AAF facilities accounted for 82.6 percent.

#### Conclusion: the Overall Production Record

Perhaps the greatest indication of the successful expansion of the American aircraft industry and the consequent reign of American air power was the amazing production record. Surprisingly, despite its 1939 inferiority, America was already the world's foremost producer of aircraft on 7 December 1941. In two years we moved from fifth to first rate. Nevertheless, our post-Pearl Harbor pro-

duction was much more impressive and probably surpassed anyone's wildest imagination.

People thought Roosevelt was using hyperbole in his 1940 call for 50,000 aircraft. But, in November of 1941, America was halfway there, and when the industry reached its peak performance in March 1944, producing 9,113 airplanes that month, the overall annual production rate was an incredible 110,000. Using airframe weight as a measure, the United States outproduced all other nations of the world combined in 1944.

The AAF was the first air arm to play an instrumental role in a nation's victorious war effort. It delivered the final blow to the Japanese in August 1945 by dropping atomic bombs from two Tinian-based Boeing B-29 Super-fortresses, the "Enola Gay" and "Bockscar," on Hiroshima and Nagasaki.

In WWII, the United States demonstrated its greatness by doing what might have seemed impossible when General Andrews told that small group of Saint Louisans in 1939 about the state of America's air arm. How did we carry out such a feat? We did it by realizing the correct combination of factors that made U.S. industry supreme, by analyzing the situation and the resources at hand, and making decisions based on the greatest amount of information possible. True, we did not have to deal with interruptions due to invasion or bombardment, a luxury unlikely in future major conflicts. Nevertheless, those involved in acquiring American air power today should revisit and remember the lessons of WWII and build on that heritage.

#### Endnotes

1. New York Times.
2. *Ibid.*
3. Goldberg, p. 173.
4. Goldberg, p. 174.
5. Zimmerman, vol. 2, p. 1.



6. Zimmerman, vol.1, p. 5.
7. Goldberg, p. 183.
8. Futrell, p. 101.
9. Holley, p. 235.
10. *Ibid.*
11. Goldberg, p. 273.
12. Futrell, p. 102.
13. Futrell, p. 109.
14. Futrell, p. 111.
15. Quoted in Futrell, p. 129.
16. Craven, p. xvi.
17. Quoted in Goldberg, p. 228.
18. Quoted in Goldberg, p. 246.
19. Holley, p. 283.
20. Holley, p. 289.
21. Zimmerman, vol. 1, p. 75.
22. Goldberg, p. 219.
23. *London [England] Daily Herald*, p. 30.

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## FIGHTER PRODUCTION IN WWII: THE P-51 MUSTANG

The plane that came closest to reaching perfection in design and performance in WWII was the North American P-51 Mustang fighter. The British were the first to realize what a great asset it was and to purchase it, demonstrating again how the United States benefited greatly from foreign orders. In 1941, the AAF operated under the assumption that big bombers could crush the enemy without escort. However, the opposite soon became clear, and the P-51 emerged as the first fighter with the combat range to escort a bomber and also engage in combat with enemy interceptors.

The P-51H had a range of 1,800 miles, a speed of 487 mph, a ceiling of 40,000 feet, and could carry six 50-caliber machine guns or 2,000 pounds of bombs. The Mustang's increased range and other improvements prompted the British to say in 1942 that the P-51 was "the best American fighter that has so far reached this country," and that it compared favorably to the British Spitfire, considered the best fighter in the world.<sup>20</sup> In November 1942, the AAF leaders finally ordered 2,200 Mustangs, but did not get a P-51 group into the European war until a year later.

Despite such a late start, the P-51 production rate was more impressive than that of any other U.S. plane. Its production rate was better than any other aircraft at two years from start of design to 500th airframe acceptance. The designs of most aircraft surfaced in the three years prior to Pearl Harbor due to increased demand. Yet, though every major aircraft was designed before Pearl Harbor, only three — the P-39, the A-20 and the P-40 — had been mass-produced prior to it. These were later eclipsed by superior aircraft such as the P-51.

In Europe, U.S. P-51s did less dogfighting than one would expect of this high-caliber pursuit machine. Instead, its utility was more evident in reconnaissance and tactical bombing. One report in the *London Daily Herald* labeled the P-51, "the creeping death," because it flew so fast and so close to the ground and yet was so quiet compared to other planes.<sup>21</sup> In Europe, the P-51 strafed and bombed a variety of targets, made an excellent spotter plane, and greatly improved ground-air force coordination. By 1944, the Eighth Air Force in Western Europe had replaced all of its P-47s with P-51s. The Mustang contributed greatly to the overwhelming air superiority the Allies enjoyed after mid-1944.